FDS8 (Apr 2017)

RGC Ref. No.: UGC/FDS14/B03/15 (please insert ref. above)

RESEARCH GRANTS COUNCIL COMPETITIVE RESEARCH FUNDING SCHEMES FOR THE LOCAL SELF-FINANCING DEGREE SECTOR

FACULTY DEVELOPMENT SCHEME (FDS)

Completion Report

(for completed projects only)

Submission Deadlines:	1.	Auditor's report with unspent balance, if any: within six months of					
		the approved project completion date.					
	2.	Completion report: within <u>12</u> months of the approved project					
		completion date.					

Part A: The Project and Investigator(s)

1. Project Title

A Global Network Decision Support System for Air Passenger and Freight Businesses

2. Investigator(s) And Academic Department(s) / Unit(s) Involved

Research Team	Name / Post	Unit / Department / Institution
Principal Investigator	Dr. WONG Wai Hung, Collin / Associate Professor and Associate Dean (External)	Department of Supply Chain, School of Decision Sciences and Information Management, HSMC
Co-Investigator(s)	Dr. CHEUNG K.Y., Tommy/ Assistant Professor	Department of Supply Chain and Information Management, HSMC
Co-Investigator(s)	Dr. WANG Yue / Assistant Professor	Department of Supply Chain and Information Management, HSMC
Others	Prof. Anming ZHANG / Professor	Operations and Logistics Division, University of British Columbia
Others	Mr CHU Kai Ching, Jeremy / Project Manager	Department of Supply Chain and Information Management, HSMC

3. Project Duration

	Original	Revised	Date of RGC / Institution Approval (must be quoted)
Project Start Date	1 November 2015		
Project Completion Date	31 October 2017		
Duration (in month)	24		

Deadline for Submission	21 October 2018	
of Completion Report	51 October 2018	

Part B: The Final Report

5. Project Objectives

- 5.1 Objectives as per original application
 - 1. To examine the air transport network configuration by constructing the traffic volume and the route development connecting major passenger and cargo airports.
 - 2. To identify the associations and relationships, competition, collaboration, or co-competition among the airports in Asia.
 - 3. To evaluate the effects of global network change, such as introducing new routes, destinations or runway on a specific airport.
 - 4. To analyse the interaction and relationship between cargo and passenger supply and demand.
 - 5. To estimate and predict the effects and effective durations of various policies and incidents on the air network change and aviation industry performances.
 - 6. To identify relationships (possibly latent) that may exist between factors affecting global air traffic volumes.
 - 7. To develop a decision support system to assist policy makers and industry practitioners to make timely decisions based on network changes.
 - 8. To propose short, medium and long term strategies of maintaining Hong Kong as the cargo and passenger hub, including but not limited to identifying new routes, revising service level of existing routes, developing ground infrastructure, etc.

5.2 Revised objectives

Date of approval from the RGC:

Reasons for the change:

1.

2.

3.

5.3 Realisation of the objectives

(Maximum 1 page; please state how and to what extent the project objectives have been achieved; give reasons for under-achievements and outline attempts to overcome problems, if any)

Research indicates that the economic performance of a city or region is intertwined with its air travel capability. It is thus important for planners and stakeholders to understand the changes in the global air transport network. Our analysis shows that there are close to 10 thousand new routes created every year, but only 25% of them can survive for 5 years. We also found that airlines had strived hard to develop new route connecting smaller airports, particularly domestic ones; however these new routes are also found to be the type with least successful rate, only less than 10% still in operation after 5 years. This shows that airlines may not be adopting the best strategy in planning new routes. Asia, particularly China and the Northeast Asian countries recorded highest growth in route development for the past 5 years. Even so, the ratio of airport to population in Asia is the smallest among all continents. This indicates Asia's high potential in further route development.

The project set out to identify the trend of global air passenger and cargo transports, analyze the relationships and threats between airports globally and within the same region, and evaluate the competitiveness of the airport. Furthermore, our studies investigated the global aviation network, taking 10 years worth's OAG data from the years 2006-2016, and established a comprehensive and objective parameterization of world airport index through the inclusion of topological metrics, continental importance and effect on multi-airport region (MAR). With this index, the world airports are classified into five tiers. Our analysis of the latest empirical data showed that some previously indubitable features of the aviation networks might have slowly changed. In particular, lower-tier airports were increasingly connected to the upper-tier airports. In fact, the number of such routes has increased by 26% since 2006. In general, there are strong growths, both in terms of traffic volumes and percentage for upper two-tier airports. The secondary class airports attained the lowest growth (14.9%) among all classes. The growth of non-MAR airports was significantly higher than that of MAR airports of the same tier.

Within a MAR, we developed a mathematical model to analyze the interactive relationship between the traffic volumes of its airports. In particular, we estimated the impacts of competition and collaboration with nearby airports on its own airport traffic. The proposed model has been applied to the four closely situated airports in the Pearl River Delta region (PRD), China, and identified the determining factors and their impacts on airport capacity. The findings showed that airport connectivity, flight frequency, airport capacity utilization, income, population, GDP, and fuel price are significant factors affecting airport's capacity. Furthermore, there was a spatially lagged effect in income and population, and a time-lagged effect in airport capacity, GDP, and fuel price.

The performance of an airport is affected by the global air transport network changes. Using the route information from the global aviation network, a methodology has been developed to forecast traffic volume of new routes. In addition, a global air transport decision support system has also been implemented to assist policy makers to understand the impact of network changes on the volume capacity of an airport in the network. It has been applied to evaluate potential new routes.

Through examining other hub airports with high in our index, our study found that government and policy supports are always behind their successful stories. Nonetheless, we found that the establishment of new route with different destination would lead to very different results in terms of network improvement and other benefits. Our aviation decision support system was used in evaluating the options for new routes from Hong Kong airport (HKG). Some of the new routes that our system had identified are now in operation, such as the route from Hong Kong to Barcelona. On top of the effort in route development, our study found that HKG should focus in collaborating with other PRD airport to minimize the harmful competition in certain overlapping routes and develop the A5 into a world-class hub airports community.

5.4 Summary of objectives addressed to date

Objectives	Addressed	Percentage Achieved
(as per 5.1/5.2 above)	(please tick)	(please estimate)
1. To examine the air transport network configuration by constructing the traffic volume and the route development connecting major passenger and cargo airports.	\checkmark	100%
2. To identify the associations and relationships, competition, collaboration, or co-competition among the airports in Asia.	\checkmark	100%
3. To evaluate the effects of global network change, such as introducing new routes, destinations or runway on a specific airport.	~	100%
4. To analyse the interaction and relationship between cargo and passenger supply and demand.	\checkmark	100%
5. To estimate and predict the effects and effective durations of various policies and incidents on the air network change and aviation industry performances.	\checkmark	100%
6. To identify relationships (possibly latent) that may exist between factors affecting global air traffic volumes.	\checkmark	100%
7. To develop a decision support system to assist policy makers and industry practitioners to make timely decisions based on network changes.	\checkmark	100%
8. To propose short, medium and long term strategies of maintaining Hong Kong as the cargo and passenger hub, including but not limited to identifying new routes, revising service level of existing routes, developing ground infrastructure, etc.	\checkmark	100%

6. Research Outcome

6.1 Major findings and research outcome *(Maximum 1 page; please make reference to Part C where necessary)*

- 1. Paper: Examination of low-cost carriers' development at secondary airports using a comprehensive world airport classification
- From 2011 to 2015, low-cost-carriers (LCCs) are expanding fast at both upper-tiers' and lower-tiers' airports, and there is a trend of shifting airport choice from lower-tiers' to upper-tiers' airports for LCCs in some continents (Asia is an exception).
- The Asia-Pacific region is generating the most airport investment in the world in 2014, we expect the LCCs expansion on Asia's upper-tiers' airports would be similar to other continents few years after the completion of these expansion projects.
- This study discovers that when a LCCs is to have connecting flight(s) with another airline on the same itinerary, there is a high chance that at least one of the "cooperating partners" is a full-service-carrier (FSC).
- 2. Paper: Spatial panel model for examining airport relationships within multi-airport regions
- For better airport planning and air traffic management, local airport authority in a multi-airport region (MAR) often needs to consider the impacts of competition and collaboration with nearby airports on its own airport traffic.
- A dynamic spatial panel regression model has been developed to test the regional effects on airports in a MAR.
- The findings show that airport degree, flight frequency, airport capacity utilization, income, population, GDP, and fuel price are significant factors affecting airport's capacity. Furthermore, there is a spatially lagged effect in income and population, and a time-lagged effect in airport capacity, GDP, and fuel price.
- 3. Paper: Is spatial dispersal the dominant trend in air transport development? A global analysis for 2006–2015
- Among the top-100 airports (by capacity), the lower-ranking airports had faster growth in their passenger shares from 2006 to 2015, suggesting a dispersal pattern in the global aviation network at the airport level.
- One reason for the dispersal of the global aviation network is a phenomenon often referred to as "hub bypassing." There was a decline in "hubness" performance by most mega- and major hubs over the 2011-2015 period. In 2011, the total mega and major hub transit traffic volumes were 59.65% of the world transit traffic, and they have decreased to 57.12% and 55.37% in 2013 and 2015 respectively.
- This study finds that the growth momentum has shifted from the US and Europe to Asia and the Middle East airports since the global financial crisis.
- Many of the mega-hub airports that have experienced a significant drop in market share are located in important alpha cities that is difficult for passengers to bypass.
- 4. Paper: How Influential Factors Affect Aviation Networks: A Bayesian Network Analysis
- Apply Bayesian network analysis to explore the factors affecting passenger and cargo traffic and the relationship between economic factors.
- GDP and inflation directly influence passenger and cargo volume, while fuel prices directly influence only cargo volume.

- 6.2 Potential for further development of the research and the proposed course of action *(Maximum half a page)*
- 1. Global Airport Connectivity Index this index has been developed to rank the airport's importance in the aviation network. It has to be regularly updated to enable airport authority or government to track performance over time and evaluate impacts of global network changes on the airport capacity.
- 2. Airport Competitiveness With our airport classification method, there is a scope for detailed econometric analysis to evaluate airports according to their competitiveness. We would expect that the effective growth of an airport capacity can be driven by the transit market potential, infrastructure, recent traffic results and spatial economic interaction from neighboring airports.
- 3. Regional Airport Competition and Collaboration this project has developed a spatial panel regression model to measure spillover effects between neighboring airports in a multi-airport region. The robustness of the model will need to be checked, as the dependence on distance (or travel time) between two neighboring airports may not be suitable for all multi-airport regions.

7. Layman's Summary

(Describe <u>in layman's language</u> the nature, significance and value of the research project, in no more than 200 words)

This study examines the changes of the global aviation network in the past decade, and provides insights into the contexts behind the successful cases, and gives suggestions on how to strengthen Hong Kong's aviation position.

The recent trend of spatial dispersal at the airport-level has weakened the importance of some traditional hub airports, as travelers may now consider using smaller airports for transit or as destination. To counteract, one should develop new routes connecting to the fast-growing cities and replace some of the routes connection to local or minor airports with limited-growth-potential. The study finds that the ratio of airport-to-population in Asia is still the smallest among all continents, this indicates Asia's high potential in further aviation development.

To stay competitive as a transit hub, both infrastructure and flight scheduling must be improved, and the support from the government is essential. Providing incentive schemes and invite more low-cost-carriers may help expand Hong Kong aviation market. Other cross-border supports such as airspace relaxation, and collaboration with nearby PRC airports will also help the growth of Hong Kong aviation development in the long-run, as this may help to minimize the harmful competition among their overlapping routes.

Part C: Research Output

8. Peer-Reviewed Journal Publication(s) Arising Directly From This Research Project

(Please attach a copy of the publication and/or the letter of acceptance if not yet submitted in the previous progress report(s). All listed publications must acknowledge RGC's funding support by quoting the specific grant reference.)

The Latest Status of Publications				Submitted					
Year of Publication	Year of Acceptance (For paper accepted but not yet published) 2018	Under Review	Under Preparation (optional)	Author(s) (denote the correspon d-ing author with an asterisk [*]) Wong W.H.*, Zhang A., Cheung	Title and Journal / Book (with the volume, pages and other necessary publishing details specified) Examination of Low-Cost Carriers' Development at Secondary Airports using a Comprehensive World Airport	to RGC (indicate the year ending of the relevant progress report)	Attached to this Report (Yes or No) Yes	Acknowledged the Support of RGC (Yes or No) Yes	Accessible from the institutional repository (Yes or No) No
				T.K.Y., Chu J.	Classification, Journal of Air Transport Management				
	2018			Wong W.H.*, Cheung T.K.Y., Zhang A., Wang Y.	Is Spatial Dispersal the Dominant Trend in Air Transport Development? A Global Analysis for 2006–2015, Journal of Air Transport Management		Yes	Yes	No
		2018		Cheung T.K.Y.*, Wong W.H., Zhang A., Wu E.	Spatial panel model for examining airport relationships within multi-airport regions, <i>Transportation</i> <i>Research Part A</i>		Yes	Yes	No
		2018		Wang Y.*, Wong W.H., Cheung T.K.Y., Wu E.	How Influential Factors Affect Aviation Networks: A Bayesian Network Analysis, <i>Transportation</i> <i>research Part E</i>		Yes	Yes	No

9. Recognized International Conference(s) In Which Paper(s) Related To This Research Project Was / Were Delivered

(Please attach a copy of each conference abstract)

Month / Vear /			Submitted to RGC (indicate the year ending of the relevant	Attached to this Bonort	Acknowledged the Support of	Accessible from the institutional
Place	Title	Conference Name	report)	(Yes or No)	(Yes or No)	(Yes or No)

July/2017/ Antwerp, Belgium	The Congestion Spillover Effects of Hong Kong International Airport to Nearby Airports	Air Transport Research Society World Conference		Yes	Yes	Yes
July/2017/ Antwerp, Belgium	Do Low-Cost Carriers Still Focus Their Business at Secondary Airports	Air Transport Research Society World Conference		Yes	Yes	Yes
Feb/2016/ Melbourne, Australia	Exploring the Evolution of Asia Pacific Air Transportation Network Structure	Second Asia Pacific Conference on Advanced Research (APCAR-2016)	2016	Yes	No	Yes

10. Whether Research Experience And New Knowledge Has Been Transferred / Has Contributed To Teaching And Learning

(Please elaborate)

- 1. A press conference on the research findings was hosted at the Mariners' Club, Hong Kong on 16th June, 2017. The report titled "Preventing Marginalization in Air Passenger and Freight Business Analysis of Global Aviation Network" was distributed at the press conference.
- Press interview by AAStocks Financial News on 16th June 2017: HK Airport, PRC Airports Should Enhance Flight Cooperation
- 3. Press interview by HK01 on 16th June 2017: 學者指港機場與廣、深機場競爭嚴重 籲三地做好分工
- 4. Press interview by 信報 on 16th June 2017: 港機場中轉優勢減 穗機場緊追
- 5. Press interview by 東網 on 16th June 2017: 載客量差距縮窄 港機場恐3年後被廣 州超越
- 6. Press interview by 橙新聞 on 16th June 2017: 粵港航線重疊競爭大 香港機場載 客量恐3年後輸廣州
- 7. Press interview by South China Morning Post on 16th June 2017: Guangzhou airport to edge out Hong Kong as dominant regional hub in 'coming years
- 8. Press report by 信報 on 17th June 2017: 港機場客量勢遭廣州超越
- 9. Press interview by Oriental Daily News on 17th June 2017: 港機場地位恐遭廣州超 越
- 10. Press report by 灼見名家 on 29th September 2017: 化威脅為助力-香港與廣州航 空業的錯位發展
- 11. Press report by China Daily on 11th September 2018: Hong Kong Airport Aims To Meet New Challenges
- 12. The research outcomes and findings of this project have also been referenced or further expanded in the Final Year Project work by our students in the Supply Chain Management degree programme. The following Final Year Project reports have been submitted to the Department of Supply Chain and Information Management.
 - a. Airport Operation Model & the Collaboration of Airports, 2016
 - b. The Evolution of Network in Global Air Transport of Low Cost Carriers During 2010-2015, 2016
 - c. The Relationships Between Multi-Airport Region and Aircraft Distribution Throughout the World, 2018
 - d. Research Study on Aviation and Transportation Infrastructure Development in

11. Student(s) Trained

(Please attach a copy of the title page of the thesis)

20 students were trained.

12. Other Impact

(e.g. award of patents or prizes, collaboration with other research institutions, technology transfer, teaching enhancement, etc.)

Some of research papers were completed in collaboration with Prof. Anming Zhang of Sauder School of Business, University of British Columbia, Canada.

RESEARCH GRANTS COUNCIL COMPETITIVE RESEARCH FUNDING SCHEMES FOR THE LOCAL SELF-FINANCING DEGREE SECTOR

FACULTY DEVELOPMENT SCHEME (FDS)

Completion Report - Attachment

(for completed projects only)

RGC Ref. No.:	UGC/FDS14/B03/15
Principal Investigator:	Dr. WONG Wai Hung, Collin
Project Title:	A Global Network Decision Support System for Air Passenger and Freight Businesses

Statistics on Research Outputs

	Peer- reviewed Journal Publications	Conference Papers	Scholarly Books, Monographs and Chapters	Patents Awarded	Other Research Outputs (Please specify)
No. of outputs arising directly from this research project [or conference]	4 (2 Accepted 2 Under Review)	3			